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latter mode of infection is particularly prevalent in children, and often leads to overwhelming and fatal disease; particularly in countries where public health standards are inadequate. Eating only well cooked pork and providing for sanitary disposal of human feces are therefore the two most important health measures for prevention of cysticercosis.

Syphilis has been called the great imitator of disease. Similarly one could consider cerebral cysticercosis as the great imitator of disease of the central nervous system. It causes convulsions, dementia, blindness, paralysis or radicular syndromes—depending on what part of the nervous system is affected. There is no specific chemotherapeutic agent available to eradicate cystocerci. However, use of steroids⁴ and anticonvulsants may be clinically helpful. Hydrocephalus may be temporarily ameliorated by shunting procedures. Cabieses⁹ has stated that operative excision of cerebral parenchymal cysts is fraught with difficulty, because of their multiplicity or the “impossibility of diagnosing and locating the isolated ones.” The introduction of computerized axial tomography may have resolved part of this diagnostic dilemma, as our case illustrates.

Summary

A large solitary parenchymal temporal lobe cysticercus cyst precipitated uncal herniation in a Korean woman, who had lived in the United States for six years. Results of computerized axial tomography, in essence, made the diagnosis. Excision of the cysticercus cyst was followed by a gratifying result.

The presentation of cysticercosis, as a large unilocular lesion appears to be uncommon, if not exceedingly rare. We were not able to find a similar case in a review of the recent literature, and for this reason the case is being reported.

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Radionuclide Studies in Coccidioid Meningitis

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ALTHOUGH the uniformly fatal outcome in untreated meningitis due to *Coccidioides immitis* has been modified by amphotericin B, use of this drug presents a challenge to therapists striving to maximize its effectiveness and minimize its not inconsiderable toxicity. Many of the complications of intraventricular therapy, using an Ommaya reservoir,¹ were encountered in a patient with coccidioid meningitis, and this experience is reported to reemphasize the usefulness of radionuclide studies in guiding therapy and assessing the progress of the disease.² The examples presented may be of interest to those faced with the difficult task of treating this still dangerous infection.

Methods

Radionuclide studies were carried out with a Nuclear Chicago Pho Gamma III scintillation camera, except for the initial cisternogram and brain scan, in which a rectilinear scanner was used. Two radionuclides were used: technetium-99m labeled serum albumin initially and ytterbium-169 diethylenetriaminepentacetic acid (DTPA) after 1972. For cisternograms, 1 millicurie amounts were administered, and for ventriculograms, ½ millicurie or less. Projections and time intervals are indicated on each figure; these varied with the purpose for the examination and the route of administration of the radionuclide. Studies were done both while the patient was in and was out of hospital.

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Report of a Case

A 15-year-old white girl was admitted to hospital on June 21, 1971 after headache, nausea and vomiting developed two weeks earlier, and diplopia the day before admission. Findings on studies of spinal fluid showed 950 leukocytes per cu mm, 85 percent of which were lymphocytes; a protein content of 152 mg per 100 ml, and a glucose value of 14 mg per 100 ml. Spinal fluid cultures were

negative for bacteria and fungi, but both serum and spinal fluid were reactive to *Coccidioides immitis* as measured by complement fixation, confirming the clinical suspicion of coccidioidal meningitis. A radionuclide brain scan showed no abnormalities, and a radionuclide cisternogram done two days after admission showed dilatation of the lateral ventricles and evidence of a partial subarachnoid absorptive block (Figure 1).

Therapy with intravenously and intrathecally given amphotericin B was begun—intrathecal administration was facilitated by the insertion of an intraventricular cannula and Ommaya reservoir. In an attempt to determine the progress of the absorptive block and suspected associated hydrocephalus, a radionuclide ventriculogram was attempted on July 20, 1971, using the reservoir as the injection site (Figure 2). The radioactivity persisted in the reservoir, and indicated obstruction in the intraventricular cannula; the injected amphotericin B remained in the reservoir. Results of repeat examinations during the next several weeks showed partial patency between the reservoir and the lateral ventricles (after vigorous irrigation at the time of injection), communication between the ventricles and the basal cisterns, and total subarachnoid block (Figure 3).

Because partial obstruction of the cannula im-

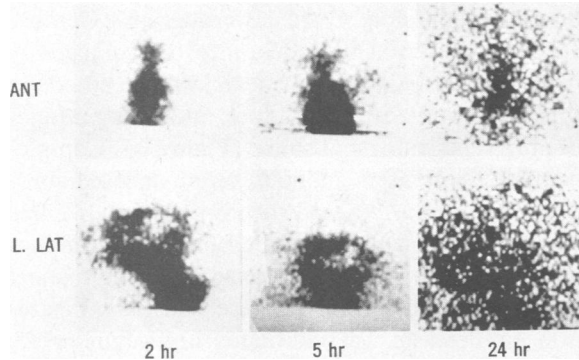


Figure 1.—Cisternogram (6-23-71). Dilated lateral ventricles and partial absorptive block indicated by delay in migration of radionuclide over the cerebral convexities.

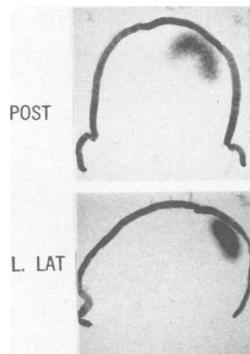


Figure 2.—Ventriculogram (7-20-71). Stasis within the reservoir, indicating obstruction in the intraventricular cannula.

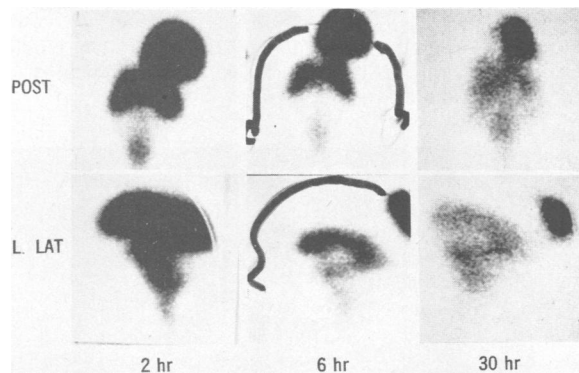


Figure 3.—Ventriculogram (8-17-71). No appearance over the cerebral convexities indicating total absorptive block. Stasis in the reservoir suggesting only partial patency in the intraventricular cannula.

TABLE 1.—*Coccidioidal Serologic Results*
(University of California, Davis
Department of Medical Microbiology)

Date	Serum				Cerebrospinal fluid		
	CF			ID	CF		ID
	1:2	1:4	1:8		1:2	1:4	
06-18-71	..	4+	..	+	0	..	+
06-25-71	4+	..	+
07-19-71	..	4+	3+	..	4+	..	..
08-25-71	..	4+	2+	..	3+	..	..
09-21-71	..	4+	2+	..	4+	..	..
10-31-71	..	2+	0	..	0	..	..
11-26-71	..	4+	..	..	2+	..	..
02-07-72	..	3+	..	..	0	..	..
05-22-72	..	+	0	..	+
09-22-72	..	3+	..	+	0	..	±
12-08-72	..	±	0	..	0
03-09-73	..	0	..	+	0	..	+
06-13-73	..	0	..	0	0	..	±
09-13-73	..	0	..	..	0	..	0
10-08-73	0	..	±
12-10-73	..	0	..	..	0	..	0
09-27-74	..	0	..	..	0	..	0
10-08-74	0	..	+
11-01-74	..	0	..	+	0	..	+
12-15-74	0	..	+

CF—Complement fixation

ID—Immunodiffusion

Empty spaces indicate test not done

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paired the distribution of amphotericin B to the basal meninges, and with increasing mental deterioration attributed to hydrocephalus, the reservoir was replaced on August 24, 1971. At the same time, a ventriculoatrial shunt was inserted, using a medium pressure Holter valve. Despite these measures the patient remained moribund for several weeks and the prognosis seemed hopeless. Intravenous and intrathecal administration of amphotericin B was continued, however, and this effort was rewarded by a spectacular clinical response accompanied by stabilization, then decline, in complement fixation titers in both serum and cerebrospinal fluid (Table 1).

The patient left the hospital on October 15, 1971, having received 2,440 mg of amphotericin B intravenously (the total intravenous dose) and 20 mg intrathecally.

Two days after discharge, the patient was readmitted with bacterial endocarditis due to *Staphylococcus aureus*. During this illness, pulmonary insufficiency developed. This lesion stabilized, fortunately, and there were no subsequent deleterious cardiovascular consequences. On a radionuclide ventriculogram (November 12, 1971) free communication between the reservoir, the lateral ventricles and the shunt was shown (Figure 4).

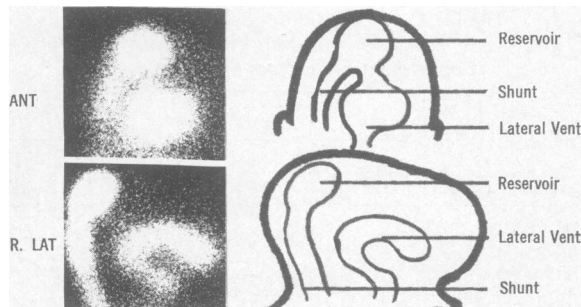


Figure 4.—Ventriculogram (11-12-71). Free communication between reservoir, lateral ventricles and shunt.

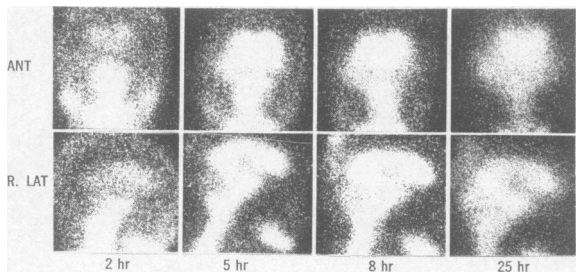


Figure 5.—Cisternogram (12-14-71). Total block at the level of the tentorium. Stasis of radioactivity within the dilated ventricles, indicative of an inoperative shunt.

Staphylococcal bacteremia necessitated a third admission to the hospital, at which time findings on a cisternogram (December 14, 1971) suggested obstruction of the shunt catheter (Figure 5). Since the catheter was suspected as the source of reinfection, it was removed and replaced. Fibrin strands were present in the distal portion of the tubing and cultures were positive for *Staphylococcus aureus*. The patient returned to full activities until nine months later, when a third episode of *staphylococcal* bacteremia required hospital admission. On a cisternogram (October 17, 1972) prompt disappearance of radioactivity from the dilated lateral ventricles was noted, in spite of a total absorptive block, indicating a functioning ventriculoatrial shunt (Figure 6). Complement fixation titers in both serum and cerebrospinal fluid had returned to normal levels (Table 1). The patient had continued to receive amphotericin B intrathecally by means of periodic injections through the Ommaya reservoir. Administration of the drug was continued until June 1973, by which time 43.25 mg had been given intrathecally.

The patient remained well for 14 months, only to be readmitted in December 1973 because of

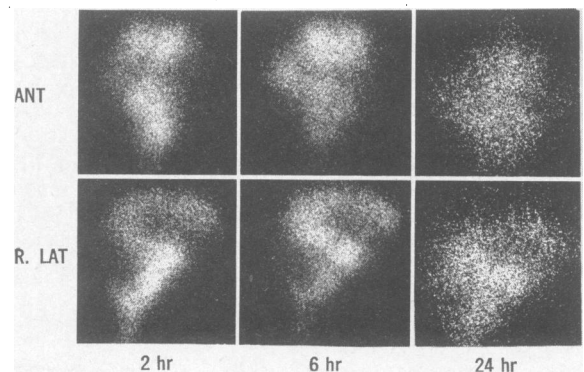


Figure 6.—Cisternogram (10-17-72). Absorptive block. Early emptying of the lateral ventricles indicates a functioning shunt.

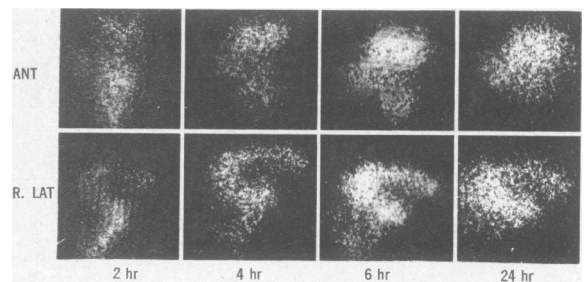


Figure 7.—Cisternogram (12-14-73). Ventricular stasis indicative of nonpatent shunt.

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a fourth episode of bacteremia due to *Staphylococcus aureus*. Findings on a cisternogram on December 14, 1973 (Figure 7) showed stasis of radioactivity within dilated lateral ventricles (in contrast to the findings on October 17, 1972) indicating an obstructed shunt. Inasmuch as the tubing was again suspected as the source of reinfection, and since there had been no untoward symptoms attributable to hydrocephalus in spite of a nonfunctioning shunt, the tubing was removed and not replaced. Cultures from the tubing were again positive for *Staphylococcus aureus*.

The patient was then well and active for eight months. In September 1974, however, headache, nausea, vomiting, convulsions and fever developed; she was readmitted on transfer from another hospital with suspected relapse of coccidioidal meningitis. Studies of the turbid spinal fluid showed 120 leukocytes per cu ml (52 percent lymphocytes), a protein content of 60 mg per 100 ml and a glucose level of 58 mg per 100 ml. Cultures of the spinal fluid were sterile for bacteria and fungi, and complement fixation titers on two occasions were negative. Immunodiffusion studies³ of the same fluid specimens gave positive results, having been negative before the relapse (Table 1).

It was felt that the findings in this case were best explained by a recurrence of coccidioidal meningitis and intrathecal administration of amphotericin B was reinstituted. An initial cisternal injection of 0.25 mg in 5 ml volume was injected over approximately two minutes. Several hours later convulsions and loss of vision in the left eye occurred. No further cisternal injections were attempted and an Ommaya reservoir was implanted to facilitate therapy. Findings on a cisternogram (September 27, 1974) confirmed the persistence of a total absorptive block and showed patency between the lateral ventricles and

the spinal subarachnoid space (Figure 8). On a ventriculogram carried out on November 1, 1974, free passage of radioactive material from the reservoir to the lateral ventricles was indicated (Figure 9).

The initial clinical course was discouraging. Mental and neurological deterioration occurred despite intrathecal drug therapy (0.5 mg doses) administered approximately three times each week, after withdrawal of fluid to relieve intraventricular pressure. However, once again the patient's condition improved dramatically and the spinal fluid findings returned to normal. Intrathecal therapy was discontinued after an additional 14.1 mg of the drug had been administered. The total dose during her illness was 57.35 mg. The patient left the hospital on December 31, 1974 and has resumed her college studies. There is a residual loss of vision in the left eye, but no other neurological signs. The only medication now being given is diphenylhydantoin for prevention of seizures.

Discussion

Primary coccidioidomycosis is most common in the endemic areas in the southwestern part of the United States and northern Mexico, but sporadic cases occur elsewhere in patients who have traveled through endemic areas or have been infected from contaminated material.^{4,5} Fortunately, less than 1 percent of primary coccidioidal infections become disseminated, and meningeal involvement is even less common.⁶⁻⁸ It is interesting that although dissemination is more common among the dark-skinned races, the opposite is true for meningitis. Perhaps the most important characteristic of meningeal infection is the tendency to localize in the meninges surrounding the brain stem, with formation of dense inflammatory tissue that may obstruct the normal cerebrospinal

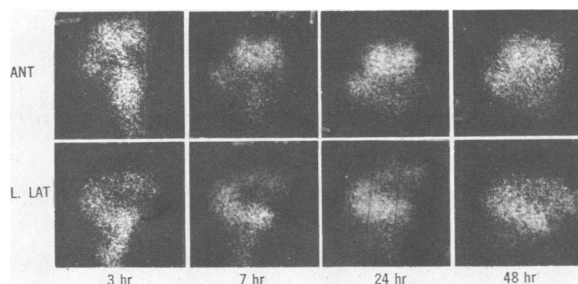


Figure 8.—Cisternogram (9-27-74). Absorptive block. Communication between lateral ventricles and spinal subarachnoid space.

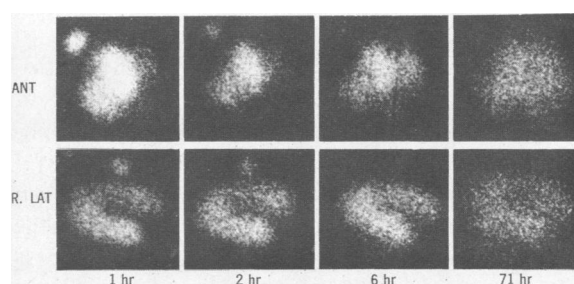


Figure 9.—Ventriculogram (11-1-74). Free entry from reservoir to ventricles.

fluid pathways and lead to communicating hydrocephalus.^{6,9-14} It is thought that this complication may be prevented or minimized by early treatment,¹⁵ although the obstruction may persist, as in the present case.

The details of the therapy with amphotericin B have been reported by Winn and others^{7,16-20} and emphasize the need for both intravenous *and* intrathecal administration of the drug because of the poor penetration of the blood brain barrier. Various routes of intrathecal administration have been used: lumbar puncture, cisternal puncture and intraventricular injection. In the latter method (commonly using the Ommaya reservoir) it is essential that there be free communication between the ventricle and the cisterns to insure that the drug reaches the site of infection around the brain stem. None of these methods are without risk. Repeated lumbar instillations result in chemical arachnoiditis, and although the use of cisternal punctures appears to be safe in skilled hands,^{17,18} life-threatening complications do occur.²¹ One cannot exclude the possibility that cisternal administration of amphotericin B during this patient's last admission was related to the subsequent seizures and loss of vision. The present case illustrates many of the problems associated with intraventricular therapy using the Ommaya reservoir technique. An exciting innovation has been suggested that may avoid many of the difficulties inherent in repeated intrathecal injection, namely, the use of hyperbaric amphotericin B administered by the lumbar route,¹⁶ but experience with this method is limited.

Radionuclide Studies

Cerebrospinal fluid dynamics and the movement of intrathecally injected medication are of prime concern to therapists in this disease. Fortunately, radionuclide imaging of the cerebrospinal fluid space is a relatively simple procedure and frequently studies can be done during therapeutic injections with no additional discomfort to the patient. Although generally innocuous, radionuclide cisternography does carry the risk of at least two undesirable consequences: aseptic meningitis and irradiation of the central nervous system. Since many of the procedures carried out in the case discussed were done so in the presence of active meningitis, the former complication is difficult to assess; no reactions were recognized when studies were done while the patient was afebrile. Cumulative radiation to the brain and

spinal cord from repeated studies was significant. Considering all procedures, approximately 3.5 millicurie of technetium-99m and 4.5 millicurie of ytterbium-169 were administered. Assuming a dose of 60 to 65 rads to the brain surface per millicurie of ytterbium-169 diethylenetriamine-pentacetic acid (DTPA)^{22,23} and further assuming a fifth this amount from equivalent doses of technetium-99m labeled albumin,²⁴ the patient received a total dose to the brain surface of 296 rads and to the spinal cord surface of 156 rads.²⁵⁻²⁸ In view of the severity of the illness and the nature of the information derived from repeated studies, the risks seem justified.

The diagnostic information was instrumental in guiding the management of this patient in several ways:

- *Cerebrospinal fluid dynamics*

Both cisternography and ventriculography were useful in showing the presence, degree and progress of obstruction in the cerebrospinal fluid pathways. Early development of hydrocephalus secondary to basal arachnoiditis was suggested by findings on the initial cisternogram (Figure 1) carried out only weeks after the onset of symptoms of meningitis, and two months later complete obstruction was shown (Figure 3). On subsequent examinations the persistence of the obstruction throughout the course of the illness despite clinical remission was confirmed.

Since in this patient intrathecal medication was given through the intraventricular cannula and Ommaya reservoir, it was essential that the ventricular fluid communicated freely with the basal cisterns. This patency was shown on several occasions (Figures 3, 6, 8). Obstruction at this site would, of course, have required an alternate route of drug administration.

- *Patency of therapeutic devices*

In the course of the illness, repeated entry into the cerebrospinal fluid space was facilitated by the Ommaya reservoir and with the development of hydrocephalus, ventricular fluid was diverted through a ventriculoatrial shunt and Holter valve. Patency of the reservoir-cannula was essential for drug administration and monitoring of ventricular fluid. Obstruction in this device was shown on one occasion (Figure 2) and led to appropriate corrective measures. The functional status of the ventriculoatrial shunt was assessed on several occasions (Figures 4 through 7) and led to replace-

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ment on one occasion and removal on another. The shunt itself was not commonly visualized, although it was shown to be present (Figure 4). The degree of stasis within the dilated lateral ventricles in the absence of normal migration over the cerebral convexities was a useful guide to shunt patency.

• Drug localization

Many of the ventriculograms done in this patient were initiated in association with therapeutic injections of amphotericin B. It is reasonable to assume that localization of the radionuclide correlated well with localization of the simultaneously injected drug, confirming that the medication was reaching the basal meninges.

Similar techniques were used to confirm cephalic migration of hyperbaric amphotericin B injected by the lumbar route.¹⁶ These studies would be even more reassuring if the drug itself could be labeled with a suitable radionuclide and monitored by direct imaging or by *in vitro* counting of samples obtained by cisternal or ventricular puncture. Periodic monitoring of drug localization would appear to be advisable when either lumbar or intraventricular injection is used.

Summary

A case of coccidioidal meningitis is presented illustrating many of the difficulties and dangers associated with the management of this disease. Radionuclide studies can provide valuable information concerning cerebrospinal fluid dynamics, status of patency of therapeutic devices and localization of intrathecally administered amphotericin B. This knowledge is helpful, if not essential, for optimal treatment of this serious infection. Therapeutic perseverance, even in the face of a seemingly hopeless situation, can be rewarded by recovery from this serious and still fatal disease.

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